9K31 Strela-1 (SA-8 Gaskin)

The Strela-1 system used as platform the amphibious BRMD-2 vehicle. The tower (turret) azimuth and the missile canister elevation setting was manually controlled with power of the muscle of the operator without any actuators or aid.

With the 9M31M missile the maximal engagement range was about 4.2 km up to 3500 meter altitude. Weight of the missile was 32 kg the warhead weight was only 2.6 kg but it had proximity fuse in contrary to contemporary 9K32 Strela-1 MANPAD.

The missile used photo contrast detector for guidance instead of infra-red. It was decided to use at the visible part of the spectrum (0.4-0.65 μm) because in that time it was the only way to provide all aspect engagement capability. The IR sensors at the time was not able to provide such feature but even photo contrast only against targets visible on a background of clear sky away from the horizon. With the contemporary Strela-1 MANPAD locking on incoming target was impossible, therefore shooting at the enemy aircraft could be only in pursuit, mainly after it performed its combat missions.

Missile was roll stabilized by the rollerons. To spin those up during launch an elegant method was used. On the rollerons a rope was spooled up it was connected to the launch container. During launch the rope was unrolled during missile acceleration and spun up. Missile had no inbuilt self-destruct system it simply safetied the warhead after 13-16 second of flight. Each vehicle had four missiles ready to launch on the turret and carried two additional missiles on the side of the chassis.

The upgraded Strela-1M was fielded in December of 1970. In comparison with the autonomous Strela-1, the Strela-1M platoon was designed to work together with a Shilka platoon directed by the PU-12M mobile air defense command post.

Strela-1M was widely used in the Warsaw Pact and in Soviet friendly countries either. The disappearance of the Strela-1M happened very quickly because of the crystallization of the propellant in the solid rocket engine which made unsafe and hazardous to use further the missiles. After about (or less than) 20 years of service disappeared from the inventories literally from all of its operators.

With today's standards the capability of the Strela-1M was very limited and its design was quite crude and basic (human powered turret, no radar, no target distance meter/rangefinder) but is left the mark on the evolution of the SHORAD IR SAMs. The base conception still lives in later designed SHORAD vehicles but in a much more advanced and elegant way.

9K35 Strela-10M (SA-13 Gropher)

The work on the creation of self-propelled air defense system 'Strela-10' began under the Decision of the Central Committee of the CPSU and the USSR Council of 24/07/1969.

Despite the fact that at the same time development of anti-aircraft gun-missile system (later called 'Tunguska') was ongoing, the creation of a simple cheap SAM, based on the further development of the complex type "Strela-1" was considered appropriate from an economic point of view. During 1974 the system was presented for state trials but failed and only accepted into service in 16 March 1976.

The Strela-10M was designed to replace the Strela-1 with 1:1 quantity ratio. The chassis is amphibious but tracked MT-LB replaced the wheeled BRDM-2 chassis. Comparing to Strela-1 the missile had an additional selectable IR mode but it was not dual seeker missile. Before the launch the operator had to select between the photo contrast or IR guidance.

The photo contrast channel (also used by the Strela-1M) did not require cooling and could be used against incoming targets (besides receding) but was not protected against natural optical interference (heavy clouds with strong contrast, horizon line). The infra channel required prior cooling and could be used only against receding targets but it was effective against natural optical interference. (Because the 9M37 missile used PbS detector with IR guidance against incoming target was not possible to perform a lock.)

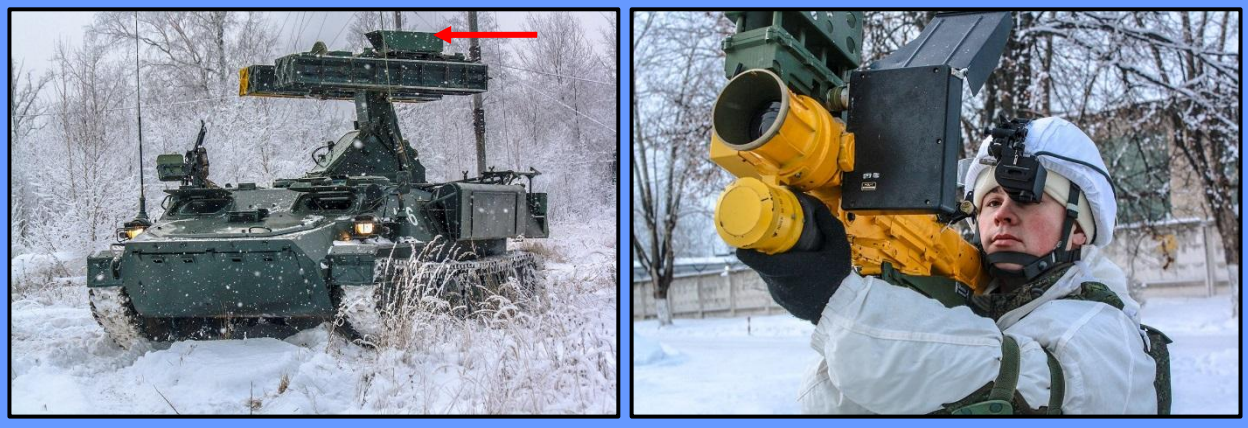
The parabolic antenna between the missile canisters is the target distance meter/rangefinder radar. While the Strela-1 relied solely on human eye to determining the distance of target being or not in the engagement zone for the Strela-10M this additional equipment was provided. The millimeter wave rangefinder radar provided firing zone and lead angle calculation.

The 9M37 missile is a bit heavier comparing to 9M31M (40 vs. 32 kg) and got a bit larger warhead (3 kg vs. 2.6 kg). The missile is equipped with proximity fuse. The vehicle carried four missiles ready to launch and four more inside for reload. It is interesting for the Osa strongly was demanded increasing the ready to launch missile quantity (from 4 to 8 but only 6 was doable) while the Strela-10M in this area did not make any improvement comparing to the predecessor system. The maximal engagement distance is 5 km up to 3500 m meter altitude. Maximal target speed against incoming targets 415 m/s, against receding targets 310 m/s.

As well as other SAM system the Strela-10 got many upgrades since the introduction. While the 9M37M had only IR/photo contrast guidance with 9E47 type guidance section it was replaced with the 9M333 variant which was applied on R-27T/ET (AA-10B/D Alamo) missiles either. The missile got laser proximity fuse against targets with small radar cross section.

The latest Strela-10M (M4) variant is equipped with night vision camera and in case of target coordinates are available via digital datalink target can be found and tracked but without datalink and radar support night engagement capability is not possible.

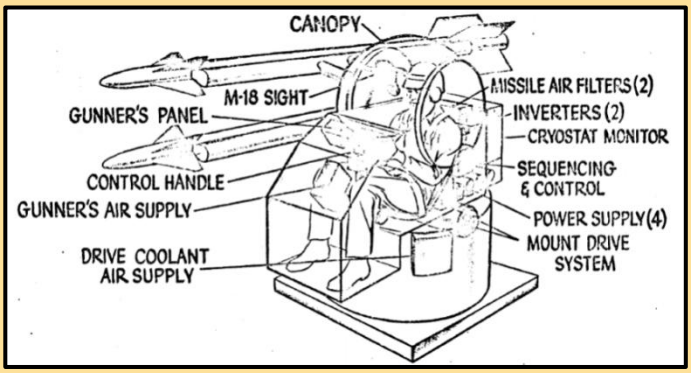
In fact with none of the IR guided MANPAD or SHORAD or similar portable system has night engagement capability without datalink and radar support because of the optical tracking requirement. Even an operator has night vision google or camera to spot an aircraft the FOV is very narrow only some degree wide because of the magnification. Only by chance is possible to find/spot a target with such a small FOV, The high magnification is required for the visual identification as well as performing the lock and the launch. Some of the SHORAD systems with laser beam riding guidance even after launch is required the continuous target tracking comparing to 'fire and forget' IR guided missiles.



On the image above left is the Strela-10MN with additional NVG camera above the canisters. Above right is an 9K333 Verba MANPAD with all additional IADS and night vision equipment.

With datalink support the turret of the SHORAD vehicles can be turned automatically and quickly can be found and tracked the target to performing lock and launch. Today even with MANPAD is possible to engage target such way because they also can have NVG support with the necessary displayed data. Of course only a very few, only the most advanced systems are capable to do this. It is not surprising such systems are mostly or only exist in Russia thanks to the heritage of Cold War development and layered army air defense.

The closest system to Strela-1/10 in the NATO was the US designed and manufactured M48 Chaparral[1] but rather developing dedicated missile it used AIM-9 Sidewinder family as a base. The M48 originally was intended only an interim solution until a much more advanced and capable SHORAD system will be available. That would be the failed Mauler. Because of the fail of Mauler the M48 eventually remained in service for almost 30 (!) years regardless it was not a well-respected system by of its operators. Because of the need and being "interim solution" the Chaparral many times was upgraded.



[1] https://www.youtube.com/watch?v=lHmKDKpsLIk , https://goo.gl/CucnR8

The first missile based on AIM-9D which lacked the all aspect capability because of the PbS detector and had only the most primitive AM guidance. The last MIM-72G missile[2] in late '80s got the most advanced seeker of its time the same what the FIM-92C Stinger variant had while the best USAF AIM-9M variant still had only FM guidance with much more primitive IRCCM solutions.

Comparing to 9K31 Strela-1 the turret design was more advanced because it was motor driven and not human powered. According to former operators of the system the turret was very uncomfortable for long work even with the aided rotation and aim.

The engagement zone – especially before the longer range AIM-9L/M missile variants – was only 4 km similar to Strela-1 but even with more advanced missiles the range was only 5 km up to 3000 meter altitude. (See the engagement envelope diagram at the end part of the chapter about 9K33 Osa. (SA-8.)

[2] *https://wiki.scramble.nl/index.php/Raytheon_AIM-9_Sidewinder#Related_variants*